AFRL-HE-WP-TP-2005-0030

AIR FORCE RESEARCH LABORATORY

Application of Cognitive Task Analysis in User Requirements and Prototype Design Presentation/Briefing

Christopher K. Curtis
Christian E. Randall
Brian Tidball

Air Force Research Laboratory
Logistics Readiness Branch
Wright-Patterson AFB, OH 45433

Scott Bachmann
Darryl Stimson

NCI Information Systems, Inc.
2850 Presidential Drive, Suite 250
Fairborn, OH 45324

David E. Kancler
Megan E. Gorman
Mary McWesler

University of Dayton Research Institute
Human Factors Group
300 College Park
Dayton, OH 45469

October 2005

Interim Report for October 2003 to October 2005

20051228 027

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Human Effectiveness Directorate
Warfighter Readiness Research Division
Logistics Readiness Branch
2698 G Street
Wright-Patterson AFB OH 45433-7604

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
October 2005	Technical Paper - Interim	October 2003 - October 2005

4. TITLE AND SUBTITLE

Application of Cognitive Task Analysis in User Requirements and Prototype Design Presentation/Briefing

5a. CONTRACT NUMBER
FA8650-04-C-6406

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER
63231F

6. AUTHOR(S)
[1]Christopher K. Curtis, [1]Christian E. Randall, [1]Brian Tidball, [2]Scott Bachmann, [2]Darryl Stimson, [3]David E. Kancler, [3]Megan E. Gorman, [3]Mary McWesler

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER
28300502

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

[2]NCI Information Systems, Inc.
2850 Presidential Drive, Suite 250
Fairborn, OH 45324

[3]University Dayton Research Institute
Human Factors Group
300 College Park
Dayton, OH 45469

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
[1]Air Force Materiel Command
Air Force Research Laboratory
Human Effectiveness Directorate
Warfighter Readiness Research Division
Logistics Readiness Branch
Wright-Patterson AFB OH 45433-7604

10. SPONSOR/MONITOR'S ACRONYM(S)
AFRL/HEAL

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
AFRL-HE-WP-TP-2005-0030

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

Clearance - AFRL/WS-05-2499, 27 Oct 2005

14. ABSTRACT

The goal of Aircraft Maintenance Intuitive Troubleshooting (AMIT) is to create job-aiding software, compatible with existing computer systems that will tell maintenance technicians what is really wrong with aircraft faster and more accurately than ever before.

15. SUBJECT TERMS
Aircraft Maintenance Intuitive Troubleshooting (AMIT), Maintenance Technicians

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Christopher K. Curtis
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAR	24	19b. TELEPHONE NUMBER *(include area code)* 937-255-6718

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. 239.18

Application of Cognitive Task Analysis in User Requirements Definition and Prototype Design

October 2005

Christopher Curtis
Capt Christian Randall
Capt Brian Tidball
Air Force Research Laboratory
Wright-Patterson AFB, OH

Scott Bachmann
Darryl Stimson
NCI Information Systems, Inc
Fairborn, OH

David E. Kancler
Megan E. Gorman
Mary McWesler
University of Dayton Research Institute
Dayton, OH

The AMIT program is an advanced research (6.3) program developed as a human performance enhancement for flightline maintenance technicians in the operational and warfighting environment.

The need for AMIT was identified as critical to reducing persistent "Cannot Duplicate", "Re-test OK" and false removal patterns that have hampered maintenance performance and readiness and have increased operating costs.

The significance of AMIT will be in researching the troubleshooting process and cognitive demands and decision points in order to identify the gaps where emerging science and technology could be applied to improve performance.

Presentation Outline

- Description of AMIT
- Method
- Results
- Application of Results

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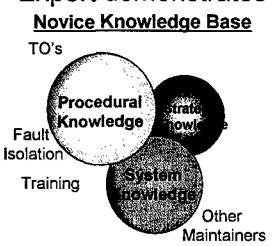
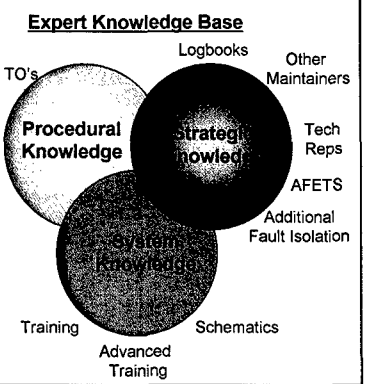
Aircraft Maintenance Intuitive Troubleshooting (AMIT) Program Description

- **Three year Air Force Research Laboratory Proof of Concept Demonstration**
- **Project Goal: Reduce aircraft downtime by improving human performance in maintenance troubleshooting of complex aircraft system discrepancies**
- **Project Objectives:**
  - Novice perform at or near expert level
  - Expert demonstrates improvement





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Technical Objectives

- **Goal: Capture and reuse expert knowledge and strategies**
- **Specific Objectives:**
  - Evaluate contextual filtering of knowledge
  - Evaluate efficient information on demand
  - Evaluate knowledge-centric approach using an intelligent broker
  - Quantify the effects of cognitive job aiding

Introduction – Why CTA

- **Baseline of expert's knowledge, thought processes, and goals (Chipman, Schraagen, & Shalin, 2000)**
- **Goals of AMIT CTA effort:**
  - Goal #1: Corroborate maintenance process with Process Interviews.
  - Goal #2: Identify cognitively complex areas of maintenance.
  - Goal #3: Define Expert vs. Novice Differences

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Method
Pre-test and Execution

- **Pre-test**
  - Validate that our CTA technique gathered the intended information
  - Subject pool consisted of aircraft maintenance personnel with equivalent expertise to our intended subject pool
  - Performed locally at Springfield ANG, OH
- **Full Test: Three sets of interviews**
  - Nellis AFB, NV
  - Hurlburt Field, FL
  - Eglin AFB, FL
  - Subject Pool cuts across bases and specialties

Method
Data Collection Techniques

- **CTA techniques used**
  - Task Diagram (TD):
    - Link cognitive requirements to specific task segments
    - Task segments identified using SMEs and prior process based interviews
  - Knowledge Audit (KA):
    - Address specific cognitive requirements
- **Data collection**
  - Psychologist Interviewer, note taker, and SME
  - Collected backup recordings for later review

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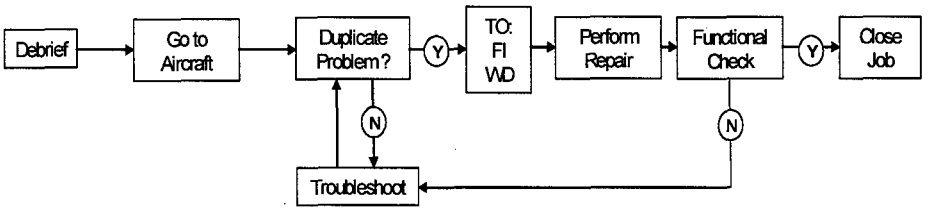
Method
CTA Interview Process

- **Task Diagram**
  - Identify primary steps in fixing an aircraft
  - Identify steps requiring difficult decisions, expert knowledge
- **Knowledge Audit**
  - Cues that the maintainer notices,
  - Strategies employed to effectively perform maintenance,
  - Problems that might be difficult for a novice to navigate.
- **"Ideal World"**
  - Outside the box concepts
  - Look for themes (e.g., communication, information archiving, fleet wide data)

Results

Goal #1: Corroborate maintenance process with Process Interviews.

Confirmed: Task Diagram is consistent across aircraft bases and across specialties.



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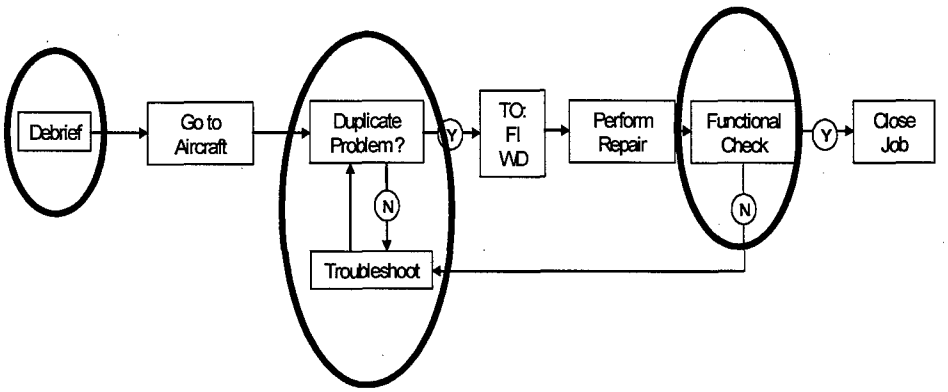
Results

Goal #2: Identify cognitively complex areas of maintenance.



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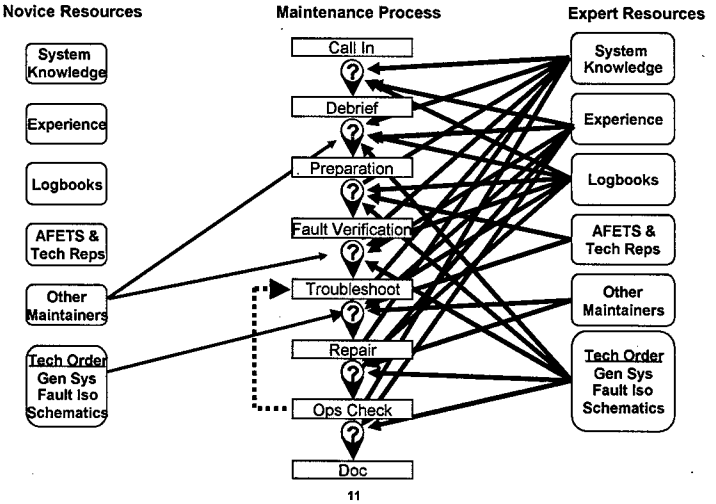
Results

Goal #3: Define Expert vs. Novice Differences.

Conclusion: Expert's are aware of, and draw from, a wider ranges of available resources.



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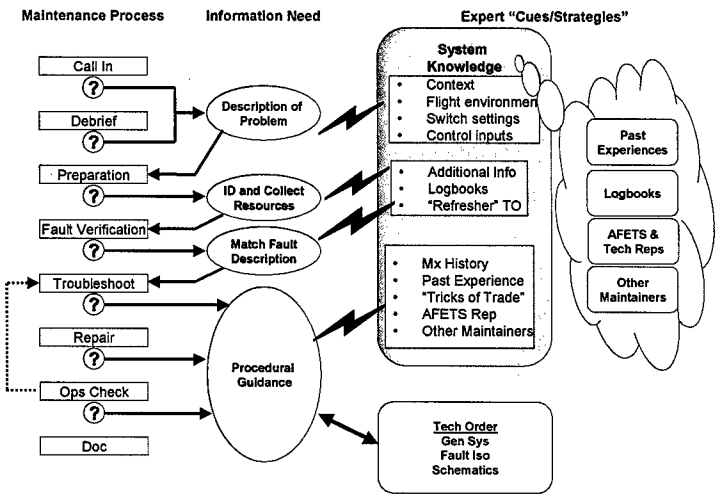
General Design Implications

- **Graphical System Representations.**
  - Connections to other systems.
  - Help maintainer build a mental model.
- **Electronic TOs.**
  - Information integration
- **Electronic Wiring Diagrams.**
  - Wiring Diagrams / Tech Order link
- **Access to Other Information Sources.**
  - Promote collaboration
  - Information push to novice

General Design Implications



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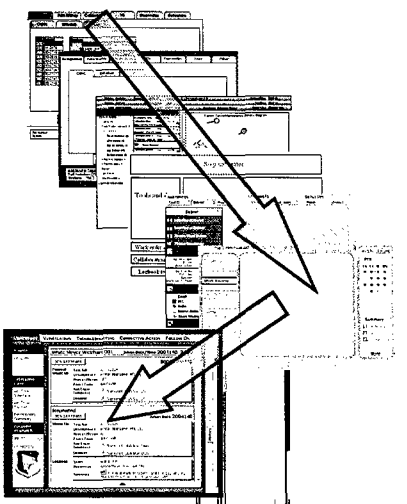
Specific Prototype Applications

- **A UI framework to orient the user**
  - Connections to other systems.
  - Help maintainer build a mental model.
- **Support work beyond the TO**
  - Information integration
- **Electronic Wiring Diagrams**
  - Wiring Diagrams / Tech Order link
- **Access to Other Information Sources**
  - Promote collaboration
  - Information push to novice

Evolution of Prototype

- **Evolution**
  - Moved from data to context centric
- **User Evaluated**
  - Validated applied CTA concepts
  - Validated notional designs
  - Provided additional "expert" perspective
- **Optimal design layout**
  - Resolved competing Novice/Expert needs
  - Screen real estate limits
- **Data research**
  - Determined presentation needs
  - Integrated disparate sources with Expert Strategies



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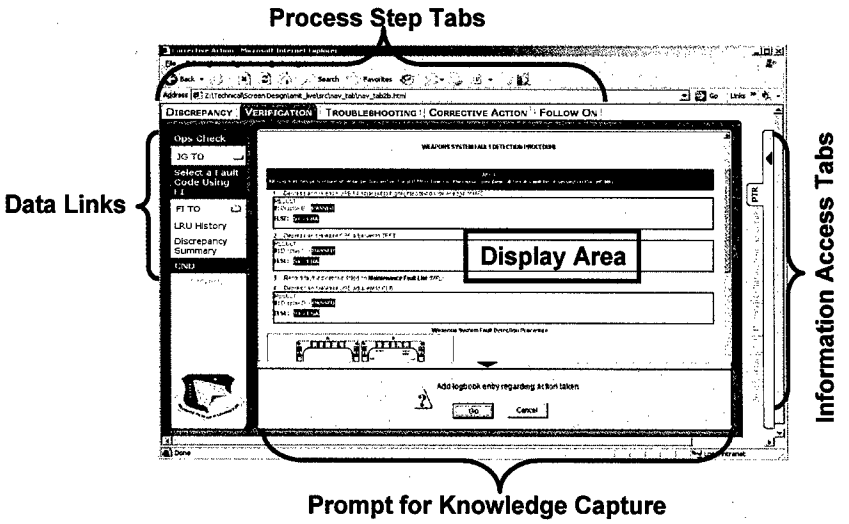
Detailed Design: AMUG

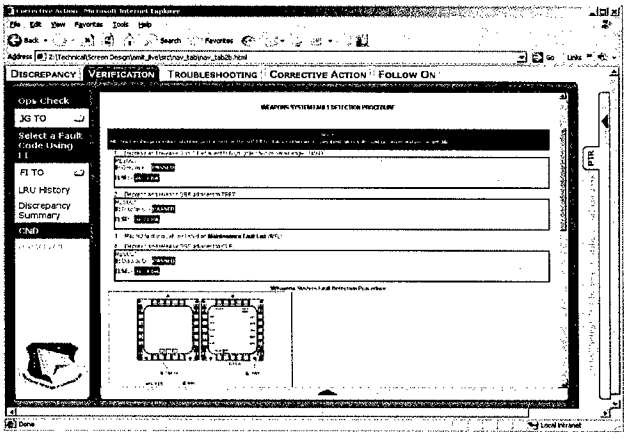
- Identified missing UI features/functions
- Identified unnecessary features/functions
- Clarified domain-specific terms and jargon
- Confirmed AMIT findings from CTA/Lit Review/Process Interviews
- Provided cross-categorical perspectives (different bases, weapon systems)

Current Prototype UI



Current Prototype UI
Context Filtering of Knowledge

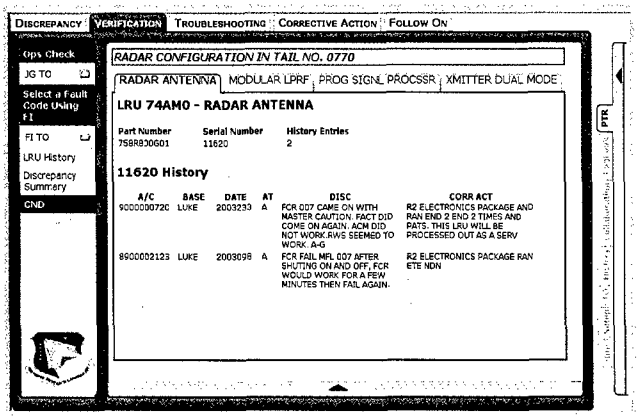
- Filtered by MX process step
- Filtered by WUC



Procedural Knowledge

Current Prototype UI
Efficient Information on Demand

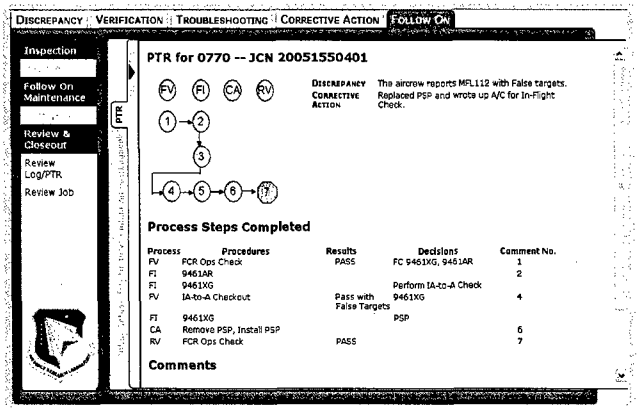
- **Search engine in background**
- **Eliminate multiple manual queries**



System Knowledge

Current Prototype UI
Knowledge-centric Approach

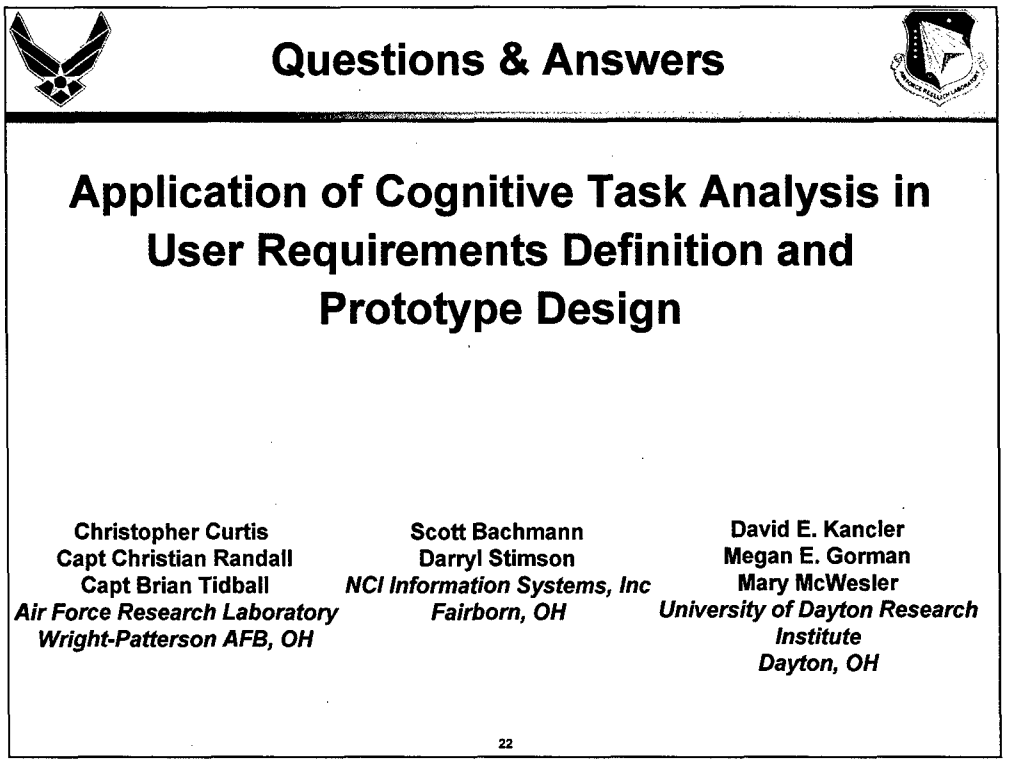
- **Problem to Resolution Tool**
- **Capture strategic knowledge**



Strategic Knowledge

Conclusions

- **Ideal maintenance world never will exist**
  - Technical data has limitations
    - Designed by engineers based on ideal conditions
  - Maintainers have varied experience levels
    - Impossible to know all possible/potential faults & causes
- **Capture and reuse expert knowledge and strategies**
  - Combined knowledge base to aid technicians
    - Reduced preparation time
    - More first-time success repairs
    - Accelerated knowledge & skill progression
  - Supplement TO data with maintainer experience



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